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TOPOGRAPHIC AND ANATOMIC PECULIARITIES OF RELATIVE LOCATION OF THE MANUBRIUM AND THE BODY OF STERNUM IN CHILDREN OF PRIMARY SCHOOL AGE

Kivva A. N.¹, Chepurnoy G. I.¹, Byashimov G. O.², Tyshlek Yu. V.¹,
Chepurnoy M. G.¹, Khoronko Yu. V.¹, Shtilman M. Yu.¹, Chumburidze I. P.¹

¹ Rostov State Medical University, Rostov-on-Don, Russian Federation

² Myrat Garryyev Turkmen State Medical University, Ashgabat, Turkmenistan

ТОПОГРАФО-АНАТОМИЧЕСКИЕ ОСОБЕННОСТИ ВЗАИМНОГО РАСПОЛОЖЕНИЯ РУКОЯТКИ И ТЕЛА ГРУДИНЫ У ДЕТЕЙ МЛАДШЕГО ШКОЛЬНОГО ВОЗРАСТА

А. Н. Кивва¹, Г. И. Чепурной¹, Г. О. Бяшимов², Ю. В. Тышлек¹,
М. Г. Чепурной¹, Ю. В. Хоронько¹, М. Ю. Штильман¹, И. П. Чумбуридзе¹

¹ Ростовский государственный медицинский университет, Ростов-на-Дону, Российская Федерация

² Туркменский государственный медицинский университет им. М. Гарриева, Ашхабад, Туркменистан

The study was performed to research the topographic and anatomic specifics in the relative position of the manubrium and the body of sternum in children of primary school age. We employed ultrasonography to examine 49 children ranging in age from 7 to 11 years (27 boys and 22 girls). The average sternal angle among the children was found to be 189.86 ± 0.74 degrees. The sternal angle value was 188.93 ± 0.97 degrees in the boys' group and 191 ± 1.1 degrees in the girls' group. Numerical parameters of the sternal angle in the examined age category were stable and demonstrated a lack of dependence on age or sex. Moreover, the range of the sternal angle values among the studied patients reached 22 degrees indicating a wide variety of potential relative positions of the manubrium and the body of the sternum in children of 7 to 11 years. Thus, presurgical detection of the angulus Ludovici in children of primary school age allows selecting the extent of surgery for patients in need of colonic esophagoplasty.

Keywords: sternal angle, children, ultrasonography

В работе проводилось исследование топографо-анатомических особенностей взаимного расположения рукоятки и тела грудины у детей младшего школьного возраста. Ультразвуковое исследование применили у 49 детей (27 мальчиков и 22 девочки) в возрасте от семи до одиннадцати лет. Обнаружено, что усреднённый показатель угла грудины у детей составил $189,86 \pm 0,74^\circ$. Размер угла грудины в группе мальчиков соответствовал $188,93 \pm 0,97^\circ$, а в группе девочек – $191 \pm 1,1^\circ$. Числовые параметры угла грудины в исследуемой возрастной категории характеризовались устойчивостью и отсутствием зависимости от возрастной и половой принадлежности. При этом амплитуда угла грудины у обследуемых детей достигла 22 градусов, что указывает на широкую возможность различного местонахождения рукоятки грудины относительно её тела у ребенка 7–11 лет. Таким образом, основываясь на дооперационном определении угла Людовика у детей младшего школьного возраста, возможен выбор объема оперативного вмешательства у пациентов, нуждающихся в колоэзофагопластике.

Ключевые слова: угол грудины, дети, ультразвуковое исследование

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Relative positions of the manubrium and the body of sternum in children may represent a clinically significant matter [1].

The cartilaginous joint between the body of the sternum and its manubrium referred to as the sternal angle (angulus Ludovici), is known mainly as an external ana-

tomical landmark widely used in clinical practice [2–5]. Anatomical variations of the sternal angle have considerable clinical significance. They may cause the incorrect count of ribs, complicate anesthesia of intercostal nerves, and sometimes represent a factor increasing the risk of sternal fracture in case of blunt chest trauma [6]. In addition, it is equally significant that the colon passed via the retrosternal tunnel in pediatric patients during esophagoplasty may become compressed because of the dorsally deflected upper part of the sternum and thus often require varied resection volume for the manubrium of the sternum [7]. For adults, the sternal angle value that allows recognizing how much the manubrium of the sternum protrudes relatively to the body was identified using skeletal measurements [8, 9]. In-life records of the angulus Ludovici degree in adults were made based on X-ray and computer tomography [10] findings. However, we could find no angulus Ludovici values for children aged 7 to 11 years. Therefore, estimating the reclination of the manubrium in pediatric patients of varied ages is a vitally important task facilitating the establishment of the need for sternal manubrium resection and its extent during esophagoplasty.

At the same time, the data could have practical relevance for children of the mentioned age group as it would allow characterizing the relative positions of the manubrium and the body of sternum, estimating the risk of transplant compression in the retrosternal tunnel following esophagoplasty, and also assist in the selection of optimal technique preventing the complication.

This work aimed to establish the topographic and anatomic peculiarities in the relative position of the manubrium and the body of sternum in children of primary school age.

Material and Methods. The sternal angle was examined in 49 patients ranging from 7 to 11 years without chest wall pathologies. The studied patients were subdivided into two groups: group I – girls (22 children); group II – boys (27 children). A Samsung Medison Accuvix V20 ultrasound scanner (Korea Republic) was used to measure in every child (with the straight line tool of the device) the angulus Ludovici formed by two straight lines along the outer part of the sternal body and the manubrium.

Informed parental consent for participation of the patients in the study had been obtained. The local ethics committee approved the study.

Statistical processing of the collected data was performed in STATISTICA 7.0 software (StatSoft Inc., USA). Processing of the findings included the calculation of the population's arithmetic mean sternal angle and the standard error of the mean. The significant difference between quantitative variables in the gender groups was evaluated using the correlative Mann – Whitney test for nonparametric data. The validity of a hypothesis about a connection between age and the sternal angle value was ascertained based on Spearman's rank correlation coefficient.

Results and Discussion. The average sternal angle among the studied children of 7 to 11 years was 189.86 ± 0.74 degrees.

Since the largest and the smallest angulus Ludovici measurements among the primary school population were registered in girls, the range of sternal angle variations in that gender group did not deviate from the corresponding finding for the entire population sample and reached 22 degrees.

Performed measurements revealed that the sternal angle in group I was 191 ± 1.13 degrees. The figure is slightly higher than the value for the entire examined primary school population.

In group II, the range of sternal angle variations did not exceed 18 degrees being numerically lower than the total range of variations among all the examined patients. The distribution of sternal angle values among the looked boys was within 188.93 ± 0.97 degrees.

The largest angulus Ludovici value was found in an 8-year-old girl (Fig. 1).

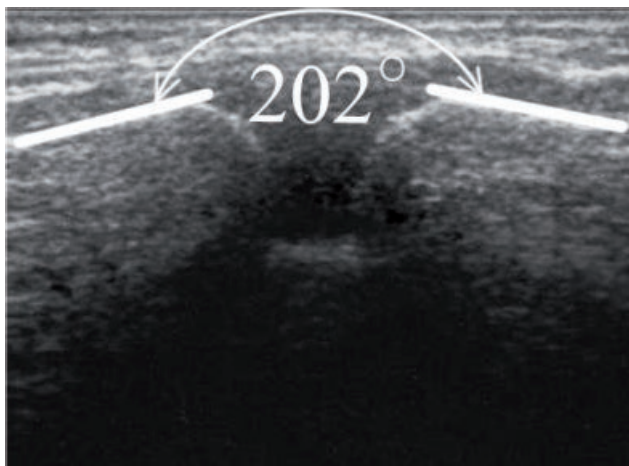


Fig. 1. Ultrasonography of patient L., 8 years. The angle between the manubrium and the body of sternum measured along its anterior surface is 202 degrees

Such sternal angle indicates that the manubrium of the sternum is considerably reclined dorsally. Should a child with such sternal angle value need esophagoplasty, the colonic transplant in the retrosternal tunnel would be significantly compressed. Elimination of the compression would require sternal fenestration along the entire manubrium.

The smallest sternal angle among the patients of primary school age was 180 degrees; the value was registered in three cases at once (Fig. 2).

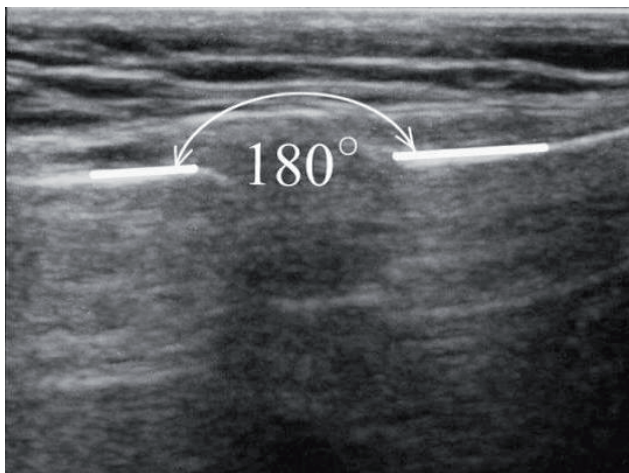


Fig. 2. Ultrasonography of patient V., 9 years. The angle between the manubrium and the body of sternum measured along its anterior surface is 180 degrees

In these cases, the measurement results indicate that the manubrium and the body of the sternum are positioned practically along the same line. Therefore, children with such angulus Ludovici value are favorably predisposed anatomically for retrosternal colonic transplant passage during esophagoplasty.

In the discussion of the study results, it should be noted that our findings are in agreement with the same for children under seven years [11, 12].

According to the data we collected, the numerical difference between the values of the parameters under study was not particularly large. Thus, examination of the girls revealed the particular prevalence of the average sternal angle value compared to the results gathered in the second group. However, statistical analysis on the Mann – Whitney test for nonparametric data (performed using the Mann – Whitney T-criterion with Yates's correction: $ZT=1.296$; $p>0.05$) determined that group differences are statistically insignificant. The above results can be interpreted as follows: gender does not affect the angulus Ludovici value in the 7–11-years-old children under study.

The study's findings cannot be compared with the views of other authors regarding the matter as the sources available to us offer no descriptions of the connection between the sternal angle size and the gender of 7–11-year-old children. Still, the sources provide various opinions on the dependence of the sternal angle value on gender in adults. There is an assertion [13] that the angle at the joint of the upper and central parts of the sternum is smaller in females. However, according to other researchers, no statistically significant differences between the sternal angle values in gender groups have been found [6, 9]. In contrast, in absolute numbers, the angle under study is smaller either in males [6] or in females [9].

To reveal the dependence of the angulus Ludovici value upon age, we checked the sample population based on Spearman's rank correlation coefficient. It was established that the correlation between the years of life and the sternal angle does not reach the reliable significance level ($r_s=0.029$; $p>0.05$).

Conclusions. Based on the above, individual specifics result in varied reclination of the manubrium of the sternum among primary school children. Thus, the discovered range of the sternal angle variations is quite wide, being estimated within 22 degrees. Since the relative positions of the manubrium and the body of the sternum are rather variable in primary school children, individual measurement of the sternal angle is required for its proper description. Further research of the relative positions of the manubrium and the body of the sternum will enable the surgeon to measure the sternal angle before esophagoplasty to see how much the sternal manubrium is reclined and, consequently, to estimate the risk of transplant compression in the retrosternal tunnel for that particular patient. The information thus collected, depending upon the sternal angle value, will be helpful for a conclusion on the expediency of sternal manubrium resection for the patient, also prompting the extent of resection sufficient to avoid transplant compression during colonic esophagoplasty.

Disclosures: The authors declare no conflict of interest.

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About authors:

Kivva Andrey Nikolaevich, MD, PhD, Professor, Professor of the Department of operative surgery and topographic anatomy; tel.: +79525877177; e-mail: a.n.kivva@mail.ru; <https://orcid.org/0000-0002-0802-9364>

Chepurnoy Gennady Ivanovich, MD, PhD, Professor, Professor of the Department of pediatric surgery and orthopedics; tel.: +79281971002; e-mail: chepur@rambler; <https://orcid.org/0000-0002-2172-1435>

Byashimov Gurbanbay Osmanovich, PhD, Associate Professor, Head of the Department of human anatomy, topographic anatomy and operative surgery; tel.: +71099365563273; e-mail: medgurozman@mail.ru; <https://orcid.org/0000-0003-0918-315X>

Tyshlek Yuri Vladimirovich, PhD, Associate Professor of the Department of operative surgery and topographic anatomy; tel.: +79282964335; e-mail: tyshlek65@mail.ru; <https://orcid.org/0000-0002-9698-2322>

Chepurnoy Mikhail Gennadievich, MD, PhD, Professor, Head of the Department of pediatric surgery and orthopedics;
tel.: +79185992229; e-mail: m.g.2012@yandex.ru; <https://orcid.org/0000-0002-7195-7067>

Khoronko Yury Vladilenovich, MD, PhD, Professor, Head of the Department of operative surgery and topographic anatomy;
tel.: +79381000483; e-mail: khoronko507@gmail.com; <https://orcid.org/0000-0002-3752-3193>

Shtilman Mikhail Yurievich, MD, PhD, Associate Professor, Professor of the Department of surgical diseases № 3;
tel.: +79282269021; e-mail: shtilmanmihail@gmail.com; orcid.org/0000-0002-0937-4573

Chumburidze Igor Pavlovich, MD, PhD, Professor, Professor of the Department of surgical diseases № 3;
tel.: +79281627537; e-mail: ic58@mail.ru; <https://orcid.org/0000-0003-4620-3615>

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SEASONAL DYNAMICS OF THE LEVEL OF CALCIDIOL IN CHILDREN WITH CYSTIC FIBROSIS LIVING IN THE SOUTH OF RUSSIA

Dolbnya S. V.^{1,2}, Dyatlova A. A.^{1,3}, Kuryaninova V. A.^{1,4}, Klimov L. Ya.¹,
Kondratyeva E. I.⁴, Enina E. A.^{1,2}, Tsaturyan S. M.¹, Cheprunova E. K.¹

¹ Stavropol State Medical University, Russian Federation

² Regional Children's Clinical Hospital, Stavropol, Russian Federation

³ Russian Medical Academy of Continuous Professional Education,
Moscow, Russian Federation

⁴ Children's City Clinical Hospital named after G. K. Filippovsky, Stavropol, Russian Federation

⁵ Medical Genetic Research Center, Moscow, Russian Federation

СЕЗОННАЯ ДИНАМИКА УРОВНЯ КАЛЬЦИДИОЛА У ДЕТЕЙ С МУКОВИСЦИДОЗОМ, ПРОЖИВАЮЩИХ НА ЮГЕ РОССИИ

С. В. Долбня^{1,2}, А. А. Дятлова^{1,3}, В. А. Курьянинова^{1,4}, Л. Я. Климов¹,
Е. И. Кондратьева⁵, Е. А. Енина^{1,2}, С. М. Цатурян¹, Е. К. Чепрунова¹

¹ Ставропольский государственный медицинский университет,
Российская Федерация

² Краевая детская клиническая больница, Ставрополь, Российская Федерация

³ Российская медицинская академия непрерывного профессионального
образования, Москва, Российская Федерация

⁴ Детская городская клиническая больница им. Г. К. Филиппского, Ставрополь,
Российская Федерация

⁵ Медико-генетический научный центр, Москва, Российская Федерация

The study included 78 children: 38 patients with cystic fibrosis (CF) (median age 8.2 [4.9–13.8] years) and 40 healthy children (median age 7.66 [2.0–12.1] years), living in the Stavropol region during 2018–2019. Vitamin D sufficiency was assessed by the content of calcidiol – 25(OH)D in blood plasma. Seasonal fluctuations in the level of calcidiol during the year in children with CF were more pronounced than in children from the control group – 12.2 [7.6–20.2] ng/ml in winter, 29.8 [21.3–37.9] ng/ml in spring, 33.2 [26.5–39.1] ng/ml in summer and 22.6 [11.4–30.5] ng/ml in autumn, in healthy children the level is 25(OH)D during 2018 was 34.8 [24.8–53.1] ng/ml in winter, 31.1 [24.6–44.6] ng/ml in spring, 30.4 [23.3–35.3] ng/ml in summer and 41.9 [32.1–55.2] ng/ml in autumn. Serum calcidiol levels were significantly lower in CF children compared to the control children group in winter ($p=0.007$) and autumn ($p=0.04$). During the study, the number of children with vitamin D deficiency and severe vitamin D deficiency significantly decreased. At the beginning of the study, severe vitamin D deficiency was detected in 40 % of patients with CF; after adjusting the dose of vitamin received in spring ($p<0.005$) and summer ($p<0.005$), it was not found in any of the children. On the contrary, the frequency of normal vitamin D sufficiency increased significantly by 36.7 % in spring ($p<0.05$), by 50 % in summer ($p<0.01$), and by 16.7 % in autumn ($p>0.05$), compared with the first determination of 25(OH)D in winter. Thus, the frequency of vitamin D deficiency in CF patients is statistically significantly higher than in healthy children. The problem of vitamin D deficiency in children with CF is quite relevant due to the low awareness of CF patients and their parents about the critical role of cholecalciferol in this disease.

Keywords: cystic fibrosis, vitamin D, 25(OH)D, preventive dose, cholecalciferol

В исследование включено 78 детей: 38 пациентов с муковисцидозом (МВ) (медиана возраста 8,2 [4,9–13,8] лет) и 40 здоровых детей (медиана возраста 7,66 [2,0–12,1] лет), проживающих в Ставропольском крае. Оценка обеспеченности витамином D проводилась по содержанию кальцидиола – 25(OH)D в плазме крови. Сезонные колеба-